Arums in which he failed to find imprisoned flies. He is clearly ignorant of Knuth's and Müller's positive statements as to the presence of imprisoned insects, and of Müller's description of the flies flying vainly against the imprisoning hairs. He describes the stigmas as covered with pollen after the anthers of the same spadix have burst—which is by no means surprising since the stigmas secrete nectar after they have ceased to function.

He throws in the gratuitous guess that the dead flies sometimes found at the bottom of the prison are killed by feeding "on the intensely acrid juice which, as is well known, is secreted by the tissues of the flower." As a matter of fact, precisely the opposite is known, namely, that "juice" of the plant is not acrid, the irritating effect of the tissues as a whole being due to minute pointed crystals. He concludes that Arum is "a purely self-fertilised flower." To one with any knowledge of the subject this statement, appended as a justifiable conclusion from such an array of arguments, is enough by itself to condemn the author.

Chapter xxiii., p. 190, is headed "Trimorphic Flowers. The cleistogamic flowers directly disprove the theory."[1] The hasty reader might suppose that the theory in question is the Field Naturalist's own hypothesis that nets are a cause of sterility. For if sterility can be produced by keeping the pollen from sun, rain, wind, &c., as the Field Naturalist states to be the case, then surely a cleistogamic flower, in which the androecium is shut up within the corolla (a covering much more impervious than a net), must be completely sterile, more especially as the reproductive parts are more or less in the dark, a condition known to produce sterility in chasmogamic flowers. This does not occur to our author, who calls the cleistogamic flower Nature's "own natural net."

The Field Naturalist completely misunderstands Darwin's point of view about cleistogamy, which, by the way, is also the view of biologists generally. Cleistogamy is an economical arrangement for securing fertilisation at any price; it is important that cross-fertilisation shall take place, but it is still more important that seedlings of any parentage should be produced. Floral structures are compromises between the two extreme forms, cleistogamy and dioeciousness, in one of which offspring is assured, in the other the offspring, *if any*, is cross-fertilised. The existence of cleistogamy, instead of being fatal to "the theory," is a most instructive part of the body of facts on which the modern view is founded. Why the Field Naturalist supposes that "cleistogamic flowers directly disprove the theory," especially in the case of trimorphic plants, is not obvious, for the meaning of cleistogamy is the same in any class of flowers. We fail to see that his discussion throws any light on the subject. The only point which is worthy of notice is a quotation (p. 191) from Darwin's "Forms of Flowers," which has several copyist's mistakes, and, moreover, contains interpolated words which do not occur in the original, the whole being within inverted commas. It is this sort of treatment of Darwin's text that makes it almost impossible to read the Field Naturalist. We can never know whether the quotations are correctly given, and life is not long enough for the verification of his innumerable citations. There is, however, little in the book but quotations and criticism, and when the reader distrusts the quotations and can see no value in the criticisms, the task of getting through the book becomes unbearable.

We would urge the author to give up his barren attempt to discredit work of such perennial value as Darwin's by niggling bookish methods. Let him rather imitate Darwin's life-long habit of absolutely honest experiment, coupled with broad-minded discussions in which all facts and considerations which oppose his views are brought into full prominence. Then, and not until then, can we take his writings seriously.

[1] We have omitted the letter "D" which forms part of the title, and shows that the chapter continues the previous section C.

CHRONOMETRY.

Exposition universelle de 1900. *Congrès international de Chronométrie. Comptes rendus des Travaux, Procès-verbaux, Rapports et Mémoires.* Pp. xl + 254. (Paris: Gauthier-Villars, 1902.)

AMONGST the numerous congresses at Paris in 1900 was one on chronometry, of which the work under review is the official publication. In addition to the "minutes" of the meetings, which include abstracts of the communications, it gives the full text of more than thirty papers and reports. These deal with such subjects as the testing of watches and chronometers, the decimalisation of time, questions of units and standards, topics of historical or current interest in horology, the description of novel instruments or materials, and mathematical and physical investigations bearing on chronometry.

M. de Vanssay, one of the secretaries to the Congress, gives an account, pp. 5–12, of the tests applied to watches and chronometers at the chief testing observatories. On pp. 153–156 is the report of a commission appointed to consider the question of watch tests, with a view to securing uniformity at different places. The commission confined its attention to the regulations in vogue at Geneva, Kew and Besançon, which are similar in general character, and to new regulations proposed for Neuchatel. While generally favourable to the Geneva-Kew-Besançon rules, the majority of the commission preferred the Neuchatel method of dealing with the results obtained at different temperatures. The commission recommends the addition of a two days' test with the watch vertical pendant *down*, excessive difference between the rate in this position and in the other vertical position pendant up to be a cause for rejection. It makes other recommendations tending to increase the severity of the tests. It recommends that the marks obtained by a watch be given only in the official list of the testing institution, and expresses a wish that all observatories should assign marks according to some common scheme.

A second subject considerably discussed was the decimalisation of time, papers on this topic occupying pp. 116–145. M. Guyou would accept the existing hour and subdivide it decimally; but he would do so only in the case of clocks or chronometers, "tropomètres," used for astronomical or nautical work, whilst the general public would be left to the existing clock or "garde-temps." M. de Rey-Pailhade is more advanced, though his argument that the metre is "admirablement proportionée à la taille de l'homme" rather savours of

antiquity. He proposes a unit the "cé" or 1/100th of the day, subdividing it into the "décicé" and "millicé." In the meantime, he would confine the system to men of science, but would teach it in the schools as soon as it meets with international approval. M. Goedseels considers the greatest obstacle to progress to be the existence of numerous tables and costly instruments based on the sexagesimal system. To help to remove this obstacle, he contributes seven pages of tables for converting time and angles to a decimal system. He takes the hour and the degree as units for one system; for a second he supposes the day divided into forty hours, the circumference into 400 grades. Dr. F. Jaja advocates a system similar to that of M. de Rey-Pailhade; but instead of "cé" he calls his unit "degré," its multiples "décagrade," "hectograde," its submultiples "décigrade," &c., down to "décimilligrade." For use by the public, he suggests for the subdivisions the titles "minute première," "minute seconde," "moment" and "instant."

The English equivalent of a "minute seconde" would be found rather awkward, and why should an "instant" be shorter than a "moment"? In England decimalisation of time may appear rather a remote topic, but it seems to have met with considerable favour at the Congress. The fact that a standing committee was appointed on the subject may not mean rapid progress, but M. Guyou mentions that his system has had a nine months' trial on five French cruisers.

Units form the subject of short papers by M. Lippmann, pp. 175-6, and Dr. Guillaume, pp. 179-183, and of a report by a special commission, pp. 184-6. M. Lippmann's paper is theoretical, treating of various alternatives to the present second as unit of time. One is based on the Newtonian constant of gravity, a second is a submultiple of the sidereal year, a third is the time of vibration of a simple pendulum the length of which (at a given place presumably) would subtend a certain angle at the earth's centre, a fourth is based on the oscillation period of a condenser. Dr. Guillaume's paper is practical. He suggests the classification of watch movements according to diameter. Taking 2 cm. as point of departure, he suggests that the interval between successive classes should be 2 mm. above this point and 1 mm. below. For balances he takes the formula $T=\pi\sqrt{I/M}$ for a French (or half) vibration, where I is the moment of inertia, and M is the "moment elastique" (stiffness) of the spiral spring. He suggests that the number of the *balance* be the value of $\pi\sqrt{I}$ and the number of the *spring* be $\sqrt{M}$, both expressed in C.G.S. measure. These suggestions meet with considerable favour in the report of the special commission. The institution of definite types, with the elimination of intermediate sizes, is, of course, an important one for watchmakers.

Amongst the papers bearing on topics of historical or current horological interest may be mentioned those by Rodanet on the proper definition of a chronometer, by Ditisheim on the classification of escapements, by Kaiser on the price and scientific value of chronometers, and by Caspari on the chronometers of the French navy. In the paper by Ditisheim, pp. 40-46, there are a number of interesting data bearing on the comparative merits of different escapements. We have also a paper by A. Cornu, pp. 55-59, on the phenomena observed in magnetised watches, with a full discussion of the effect of changing the position of a magnetised watch relative to the earth's field; while Brillouin, pp. 164-174, treats experimentally of rapid variations in the amplitude of oscillation of balances, with special reference to the question of the shape and finish of the teeth of wheels.

Amongst the papers dealing with instruments may be mentioned those by A. Cornu, pp. 47-54, on the clock at Nice, by Maillard Salin, pp. 63-5, on "montres-a-billes," by Féry, pp. 69-72, and Thury, pp. 146-152, on applications of electricity, by Borrel, pp. 204-7, on a kind of Venetian blind semaphore for signalling time to ships, and by C. W. Schmidt, pp. 113-5, on his chronograph. This last instrument appears to be employed in France for measuring the velocity of projectiles, and is said to give velocities up to 700 metres a second correct to about 1 part in 500 A specially important paper is that by Dr. Guillaume, pp. 90-112, on nickel steels and their applications to horology. The substance of this paper has mainly been published elsewhere, but it is presented here in a convenient form and it attracted considerable attention at the Congress. Dr. Guillaume has yet another interesting communication, pp. 195-7, on an instrument for drawing the terminal curves of spiral springs in accordance with the results of Phillips's well-known application of the mathematical theory of elasticity.

The mathematical papers, though mentioned last, are by no means least in evidence. M. Faddegon, pp. 13-33, treats of the effects of changes of temperature on ordinary and on compensated pendulums. The formulæ he arrives at for the "grid-iron" pendulum are complicated and those for the mercury pendulum still more so. In the latter case we encounter on p. 27 a determinant with ten rows and columns, and the mere look of the formulæ on pp. 32 and 33 will probably suffice to damp the ardour of anyone anxious to combat the author's conclusion, on p. 31, that it would be well for scientific purposes to give up attempts at compensation and revert to homogeneous pendulums.

M. Goedseels, pp. 73-89, treats of mathematical processes, less exhausting than least squares, for determining constants in linear formulæ containing a considerable number of terms. Comparing the methods of Cauchy and of Tobie Mayer, he concludes that in point of simplicity the advantage rests sometimes with the one, sometimes with the other, according to the circumstances of the problem. But in the case of the ordinary 6-term formula for the rate of chronometers he decides in favour of Mayer.

The final mathematical memoir, pp. 217-252, consists apparently of a collection of already published papers by M. E. Caspari, the acting president, which the Congress decided to reprint. The common subject is the isochronism of helical springs. Calculations are made, after the methods of Phillips, Resal and Yvon Villarceau, of the influence of the "centrifugal force" acting on the balance through its own motion, of the inertia of the spring, and of air resistance, friction, &c. There is also an investigation into the possibility of obtaining isochronism by varying

the length of the spring without having its terminal portion shaped after one of Phillips's curves. On p. 240 it is concluded that, provided the windings are numerous enough, there are in each turn two points diametrically opposite, the attachment of which to the balance would procure isochronism. The paper contains also references to some experiments, and certain mathematical functions are tabulated. The memoir is one which only an expert elastician can follow, while an unprejudiced technical expert could alone judge of its practical value. This implies a combination doubtfully existent in England.

The book as a whole is full of ideas, and contains in addition many valuable facts. It is well worth the attention of horologists, whether practical or theoretical. In some of the papers, however, there are indications of a little haste, or of careless proof-reading. M. de Vanssay's description of the Kew watch trials seems to be founded on a set of regulations superseded in 1890. He specifies different rejection limits as applying to ordinary class A watches and to those obtaining the distinction "especially good." This is not now the case, the distinction denoting simply the attainment of at least 80 per cent. of the total possible marks. In some of M. Faddegon's mathematical expressions there are a few rather obvious misprints, and the paging is wrong in the few cross-references in the text of his paper.

In M. Féry's description of a pendulum with electric "restitution" the letters employed in the text are omitted in Figs. 1 and 2 on p. 70, rendering the description difficult to follow. There are a good many slight errata in intermediate steps in M. Caspari's memoir. Thus on p. 234 the sign of equation (7) is wrong, and the term containing b in the line above is also given incorrectly. The suffix in a_t is omitted somewhat arbitrarily on pp. 239 and 244, and on the latter page its factor $\sin\phi$ is omitted several times. The errata, however, are seldom of a kind likely to cause serious trouble.

C. C.

TRADES' WASTE AND RIVER POLLUTION.

Trades' Waste: its Treatment and Utilisation. By W. Naylor. (London: Charles Griffin and Co., Ltd., 1902.)

IN this volume the author, who is the chief inspector of rivers of the Ribble Joint Committee and consulting engineer on sanitation and rivers' pollution to the Somerset County Council and other public bodies, has put together the results of his experience and observation, as to the causes of the pollution of rivers and as to the best known practical means of preventing it. The subject, it need hardly be said, is of the greatest importance, but it is also one of ever-increasing difficulty and perplexity. It has been forced upon public attention with more or less insistence at irregular intervals during the last half century. In 1867 the whole question was relegated to a Royal Commission, the reports of which are justly styled by the author as by far the best production on the subject hitherto published in any country. The labours of this Commission paved the way for the Rivers' Pollution Act of 1876, but this, as administered by the various local sanitary authorities, proved to be of little practical good. There can be no question that if it had been efficiently administered much might have been accomplished, and by simple means, and we should not have had to wait for the more costly operations which have resulted from the Local Government Act of 1888. Had the local authorities put the Act in operation with the vigour which they showed in the case of the Alkali Works Regulation Act a great public benefit might have been effected with comparatively little friction or irksomeness. The author points out how the opportunity was allowed to slip.

"Land on which to instal plant might have been obtained which cannot now be procured, and machinery might have been put down, and drains laid at levels which would have permitted the interception of the drainage without the resort to pumping now in many cases necessary. But this was not done. Manufacturers are just as much to blame themselves as anybody. In many cases it was due to their opposition as large ratepayers or to their personal influence on the local governing authorities, that the Act remained a dead-letter."

Whether the larger powers vested in such bodies as the two boards of the Mersey and Irwell Joint Committee and the Ribble Joint Committee, some of which have also been acquired, or sought to be acquired, by county councils, will result in a larger measure of good remains to be seen. But it is evident from the manner in which various trade associations, as, for example, the Paper Makers' Association, have been moved that a more stringent administration of the Act throughout the country is in contemplation, and that the opposition, overt or covert, of many of the manufacturers has still to be reckoned with.

In a chapter on chemical engineering the author deals with the general principles underlying the treatment of trades' waste, either as liquid or semi-solid products. He discusses the "laws" regulating the subsidence of solid particles floating in liquids, the conditions determining their aggregation and the various modes in which precipitants are manufactured. He then gives typical illustrations of the application of these principles as carried out in actual practice, as in the Mather and Platt system and in the continental tank systems. He gives details of the mode of construction of precipitation tanks, together with a design of retaining walls for resisting hydraulic pressures, &c. This chapter is illustrated by diagrams and plans, together with a number of well-executed "process" reproductions of photographs of installations in actual use. It is not, however, very obvious why it should be headed "Chemical Engineering," since it is mainly concerned with the application of physical and mechanical principles to the filtration and clarification of more or less turbid liquids.

The remaining chapters, seven in number, deal with some of the special industries which produce waste in notable amounts, such as woollen mills, tanneries and fellmongeries, breweries and distilleries, bleach and dye works, calico printing works, paper making and chemical works. As a matter of fact, however, the author treats only comparatively few of the waste-producing industries.

The various industries, adopting the classification of the Society of Chemical Industry, may be grouped into twenty-two classes. According to the author, only five of these may be said to have no liquid waste of consequence as regards volume, whereas the remaining